

## Specification

### Fishing Line

The invention relates to a fishing line.

Fishing lines with a high resistance to breaking are known, which are either designed as monofilaments or, on the other hand, consist of a multitude of braided cords, wherein synthetic fibers of great strength are employed for this, which is referred to in DE 44 02 630 C1, for example. As a protection against damage, such threads and cords are provided with a casing, for example by coating or extrusion, which is referred to by way of example in WO 92039922 A1. The employment of adhesive materials, such as hot melt adhesives, for improving the adhesiveness between the casing and/or the filaments is disadvantageous in connection with known hybrid fishing lines. Such bonding layers/adhesive layers have a negative effect on the mechanical properties and fatigue strength under reversing bending strains of the fishing line, and in the course of time are also subjected to becoming brittle, to disintegration effects and to decomposition effects.

Braided or twisted fishing lines moreover have the disadvantage that the elongation at break is not inconsiderably increased by twisting. On the other hand it is also possible when using the fishing line in sea water, that in the course of retrieving the fishing line water droplets become caught between the individual filaments and leave salt crystals behind when they dry, which leads to destruction by friction when unreeling the fishing line again.

The object of the invention is based on creating a fishing line which will satisfy the high demands made when it is used in sea water and for large fish. Among the demands made on fishing lines are a large support capacity with little wear, nip resistance, large resistance to breaking, very low elongation at break, a smooth surface for good sliding properties, a water-repellent and dirt-repellent surface, tinting capability, good resistance to knotting, high fatigue strength under reversing bending strain, flexibility, UV resistance, weather resistance, transverse strength as high as possible, high abrasion resistance.

This object is attained by means of a fishing line in accordance with claim 1, which is furthermore universally

employable and easy to handle.

The fishing line in accordance with the invention is distinguished in that it has a core of at least one multifilament yarn on the basis of synthetic organic fiber materials, and a casing made from small film strips of polytetrafluoroethylene (PTFE), which have been firmly wound on the core in the S-direction and Z-direction or vice versa. Preferably the winding takes place alternately. With thicker cores, fishing lines, it is also possible to first wind two or more small film strips in the S-direction or Z-direction, or vice versa, and thereafter at least one small film strip in the other direction around the core.

The fishing line formed in accordance with the invention meets all requirements made on it in regard to high strength, breaking resistance and transverse strength, along with a very low elongation at break, and because of the casing made of small film strips of PTFE, it not only has very good sliding properties, but is also UV-resistant, water-repellent, dirt-repellent, has a high abrasion resistance and its appearance can also be changed by tinting.

Advantageous further developments of the fishing line in accordance with the invention can be taken from the distinguishing characteristics of the dependent claims.

It is possible in particular to wind the small film strips made of PTFE around the core of multifilaments in such a way that a closed sheathing - casing - is formed.

In accordance with the invention, the core made of synthetic, organic, endless filaments, which can be formed individually or in bundles, can consist of multifilament yarns or spun yarns, lends the yarn the required breaking resistance with low elongation at break and the high support capacity, while the small film strips made of PTFE as the sheathing provide the required exterior properties, such as sliding properties, fatigue strength under reversing bending strain, abrasion resistance, UV-resistance, weather resistance, water-repellent properties, chemical resistance, ability to be tinted. By means of the small film strips it is possible to provide a sheathing which is closed like a casing wherein, because of winding a small film strip made of PTFE around the core, i.e. a flat structure in contrast to filaments which have a linear structure, the transverse strength of the core is

additionally increased, since by means of this winding the breaking resistance of the small film strips made of PTFE as the sheathing contribute to the increase of the cross breaking resistance of the filaments of the core. A circular cross section of the fishing line can also be achieved by means of winding the small film strips around the core. In a particularly preferred embodiment of the invention the fishing line is wound with only two small film strips made of PTFE, which constitute the casing, wherein one of the small film strips is wound around the core in the S-direction and the other small film strip in the Z- direction, wherein the small film strips are attached to the core or to each other over the entirety one side. A firm connection between core and casing is created by the appropriate firm winding of the small film strips around the core.

The construction of the fishing line of only two components without a coupling agent, namely the thermoplastic material of the core and the casing, results in a high degree of flexibility and a fatigue strength under reversing bending strains.

The small film strips made of PTFE have preferably been wound with 200 to 400 turns/m around the core. For the sheathing, the small film strips used for producing the fishing line preferably have a width of 1 to 2 mm, in particular 1 to 1.5 mm. Small film strips made of PTFE of 220 to 880 dtex are in particular used for the sheathing. In this case, 350 to 450 dtex is a preferred range.

Such small film strips made of PTFE are produced by cutting up very thin PTFE films. Preferably the small film strips are made of 100% pure PTFE. PTFE can be permanently subjected to up to 260°C and will tolerate short time temperature peaks - use temperature - up to 300°C. PTFE is not flammable, since the limiting oxygen index (LOI) lies at 95% O<sub>2</sub>. The hairline breaking resistance of small film strips made of PTFE lies in the range between 2.7 to 3.0 cN/dtex with an elongation at break of at most 6%.

In comparison with sheaths of thermoplastic materials, for example, extruded on the line, the resistance to knotting of the fishing line in accordance with the invention is also improved by the casing made from small film strips made of PTFE since, by means of the firm winding of the small film strips on

the core, the cross breaking resistance of the core is also increased.

In accordance with the invention, high-strength filaments made of organic synthetic fibers, in particular multifilament yarns with an elongation at break of less than 8%, preferably less than 6%, and preferably less than 4%, are preferably employed for the core of the fishing line. The linear density breaking resistance of the multifilaments employed for the core should be at least 20 cN/dtex.

In order to achieve maximum strength along with the least possible elongation at break of the fishing line in accordance with the invention, the high-strength filaments and multifilament yarns constituting the core are aligned with each other substantially straight and extending parallel with each other, i.e. they are neither twisted in themselves or with each other. In this way it is achieved that the fishing line does not curl. With a core whose filaments or multifilament yarns are not twisted, the original elongation at break is maintained, i.e. it is not increased, since no structural elongation is added, such as is created, for example, in the course of twisting or braiding of filaments. The multifilament

yarns used for the core are preferably also not twisted.

On the other hand, it is also possible in connection with the fishing line of the invention to slightly twist the filaments/multifilament yarns constituting the core with each other by 1 to 30 turns/m, wherein untwisted multifilament yarns can also be employed. Here, too, the low elongation at break is substantially maintained. But, in connection with fishing lines of great breaking resistance and very low elongation at break, it is also possible to twist the filaments/multifilament yarns constituting the core with each other with more than 30 turns, but preferably no more than 200 turns/m.

It is essential for the embodiment of the fishing line in accordance with the invention that the core and the casing constituted by the small film strips made of PTFE are mechanically put together into a unit without any adhesive layers, such as a glue layer, hot melt adhesive or other binders, by the firm winding of the small film strips made of PTFE around the core. A large degree of flexibility and a fatigue strength under reversing bending strains result from this.



Preferably filaments in the form of multifilament yarns are employed for the core. Multifilament yarns are composed of individual filaments of a thinness of less than 10  $\mu\text{m}$ , wherein a multifilament yarn of 550 dtex is composed of approximately 85 to 90 filaments of a thinness of 6  $\mu\text{m}$ , for example, however, the filaments can even be very much thinner up to a diameter of 2  $\mu\text{m}$ . Multifilament yarns of different sizes, depending on the application purpose, are preferably employed for the core, for example 220 dtex, 440 dtex, 1,200 dtex, preferably within the range of 110 to 1,800 dtex. Multifilament yarns, whose filaments are not twisted together, are customarily used.

In accordance with a preferred embodiment of the fishing line in accordance with the invention, high-strength filaments/multifilament yarns made of polyethylene of an ultra-high molecular weight (UHMW-PE) of 110 to 1,700 dtex and a linear density breaking resistance of at least 20 dN/dtex, in particular at least 25 dN/dtex, and an elongation at break of less than 8%, in particular less than 6%, are used. This is a core which lends a very large support capacity with a very low elongation at break to the fishing line. Customarily identical filaments/multifilament yarns are used for the core of the

fishing line. However, in case of a requirement for additional properties it is also possible to embody the core by means of filaments/multifilament yarns which are structurally different in respect to their material and/or shape. It is provided in accordance with a preferred further development of the fishing line in accordance with the invention to provide at least one conductive filament or filament yarn on the basis of a thermoplastic material in addition to the filaments/multifilament yarns made of synthetic organic fiber materials of the core. Filaments/filament yarns having an electrical resistance of  $10^0$  to  $10^{10}$  Ohm/cm are employed as such conductive filaments/filament yarns. The conductive filament yarns preferably contain nylon or a polyester as the thermoplastic material. Conductivity is achieved by the addition of carbon, wherein this can be contained in the filament and/or is vacuum-deposited onto it. A content of 5 weight-% carbon in relation to the filament is sufficient. Conductive filaments/filament yarns of thin construction are preferably employed, preferably in the range of 18 to 40 dtex. Here, a conductive filament yarn preferably can have between 1 and 10 filaments. Nylon with a melting point in the range of

approximately 215°C, or polyester with a melting point of approximately 255°C, are preferably used for the conductive filament yarns. The conductive filament/filament yarn also contributes to improving the adhesion of the filaments. However, it is essential that the core of the fishing line predominantly consists of multifilament yarn of great breaking resistance and low elongation at break and only contains a small proportion of conductive filament yarn, preferably in the range of 3 to 12 weight-% in relation to the core. It is also possible for the multifilament yarns of the core of great breaking resistance and low elongation at break to be twisted together with the conductive filament yarns, wherein the twisting can be provided as S- and/or Z- turns, wherein maximally up to 30 twisting turns/m are provided. Because of the twisting of the conductive filaments/filament yarns together with the remaining multifilament yarns of the core, a reinforcing effect is achieved in such a way that the transverse strength of the core is increased and therefore the knotting resistance of the fishing line is improved. By means of the twisting, wherein the thin conductive filament yarn is embedded in the surface of the remaining multifilament yarns of

the core, the desired round shape of the cross section of the core, and therefore also of the fishing line, is better achieved. The core achieves the required smoothness, flexibility, abrasion resistance, water resistance and sea water-repellent properties, as well as UV-resistance, by means of the sheathing made of the small film strips of PTFE.

A preferred embodiment of the fishing line in accordance with the invention comprises a core of high-strength filaments of polyethylene of an ultra-high molecular weight (UHMW-PE) of 300 to 400 dtex and a linear density breaking resistance of at least 28%, and an elongation at tear of less than 4%, as well as conductive filament yarn on the basis of nylon or polyester of 3 to 8 weight-% in relation to the total weight of the core, wherein the casing is constituted by two small film strips of PTFE, one of which is wound around the core at 200 to 400 turns/m in the S-direction and the other in the Z-direction, or vice versa, wherein the small film strips made of PTFE have a width of 1 to 1.5 mm and the filaments/filament yarns and conductive filaments of the core are not twisted, and a closed casing is formed by the winding with the small film strips made of PTFE. The water-repellent embodiment of the sheathing made

of PTFE and its closed state prevent the penetration of the fishing line by water/saltwater, so that no salt crystals are left behind after drying, and the fishing line maintains its sliding ability and capability to function for winding and unwinding for a long time.

Fishing lines in accordance with the invention have a high linear support capability which, when employing multifilaments made of UHMW-PE for the core, is at least 35 g/den (31.5 g/dtex).

When using multifilament yarns made of UHMW-PE of 200 dtex (200 dernier) for the core with a break resistance of 31 cN/dtex, or 35 g/den, a fishing line in accordance with the invention with a diameter of 0.19 mm has a support capability of approximately 8.1 kg, which is composed of 5.2 kg as the part of the core and 2.9 kg of the casing constituted by the small film strips made of PTFE.

In connection with a fishing line in accordance with the invention with a diameter of 0.35 mm with multifilaments made of UHMW-PE of the core of 880 dtex (800 dernier), a supporting capacity of approximately 30 kg results, which is composed of 28 kg based on the core and further 2.5 to 3 kg of the

sheathing of the core with small film strips made of PTFE.

Since the specific weight of the small film strips made of PTFE is higher than that of water, while the one of the multifilaments of the core of, for example UHMW-PE, is slightly lower than that of water, it is possible to determine the weight of the fishing line by means of the proportion and the ratio of the weight of the core to the weight of the casing, so that it is designed to be somewhat heavier than water and does not float on the water, but sinks. The specific weight of the fishing line preferably lies in the range between approximately 1.5 to 1.8 g/cm<sup>3</sup>. A heavier fishing line furthermore has the advantage that it can be cast better since it develops a higher kinetic energy. In this connection the design of the non-twisted core made of filaments/multifilament yarns is also of advantage, because the fishing lines does not have a tendency to curl.

The fishing line in accordance with the invention is schematically represented in drawing Fig. 1 with the individual components of the manufacturing process. The fishing line 1 is comprised of the core 10 composed of filament yarns 101, which consist of untwisted filament yarns extending parallel with

each other, and wherein the filament yarns 101 are also arranged parallel side-by-side without twisting. Two small film strips 201, 202 made of PTFE are wound around the core, wherein the small film strip 202 is wound in the Z-direction and the small film strip 201 in the S-direction - or vice versa -, wherein the two small film strips form a closed casing 20 made of PTFE. For example, the small film strips 201 and 202 are firmly wound around the core 10 with 200 to 400 turns/m, wherein the full surface of one side is wound around the core, or around the first small film strip already applied there. Because of the core being wound with the small film strips 201, 202 in this way, the cross breaking resistance of the core, and therefore its resistance to knotting is additionally improved. The core 10 and the sheathing 20 form a solid connection with each other without the use of any adhesives or the like.

In a further development of the invention it is also possible, see Fig. 2, to construct the core 10 of the fishing line of different filaments/filament yarns 101, wherein in addition to filament yarns 101 made of a high-strength synthetic fiber, for example preferably UHMW-PE, one or two conductive filaments or filament yarns 102 are added, which

either form the core, not twisted together with the remaining multifilament yarns 101, or they are twisted together with it. The conductive filament(s) 102 consist(s) for example of thermoplastic polyester or nylon and has (have) been made conductive by vacuum deposition of a small amount of carbon, for example 5 weight-% in relation to the filament. The conductive filament yarn can be composed of a few individual filaments and preferably has a reduced strength of, for example, 30 dtex. The core 10 in accordance with Fig. 2 is subsequently wound with two small film strips made of PTFE, as represented in Fig. 1, which form a continuous sheathing, which is also dirt-repellent.

#### Exemplary Embodiment 1:

A core is twisted together, for example in an S- rotation at 20 turns/m, from a multifilament yarn made of synthetic fibers of polyethylene of an ultra-high molecular weight UHMW-PE of a density of 0.97 g/cm<sup>3</sup>, a breaking resistance of 3.1 N/tex, or 35 g/den, a module of elasticity of 97 N/tex, and an elongation at break of 3.6%, for example a Dyneema<sup>(R)</sup> fiber of



220 dtex, together with a conductive filament yarn of 22 dtex containing three filaments on the basis of nylon 6, as well as 5 weight-% of carbon applied by vacuum deposition on the surface, which has an electrical resistance of  $10^6$  to  $10^8$  Ohm/cm and an elongation at break of 53% and a breaking resistance of 2.9 cN/dtex. Subsequently two small film strips made of PTFE of 420 dtex of a width of approximately 1.5 mm with 300 turns/m are wound around the core. The fishing line so obtained has a diameter of 0.19 mm, has an elongation at break of 4% and has a linear support capacity of 8.1 kg composed of a proportion of the core of 5.2 kg and of the sheathing of small film strips made of PTFE of 2.9 kg. The fishing line is sea water-resistant, abrasion-resistant, has a smooth surface, is flexible, has a very good resistance to knotting and fatigue strength under reversing bending strain, it is UV-resistant, dirt-repellent and meets all requirements.

#### Exemplary Embodiment 2:

An untwisted core is produced from two multifilament yarns of 220 dtex and a multifilament yarn of 440 dtex of the

same material as described in connection with exemplary embodiment 1, which is subsequently firmly wound with two small film strips made of PTFE of 420 dtex and a width of approximately 1.5 mm, wherein one small strip is wound in the S-direction and one small strip in the Z-direction around the core. Winding takes place at 300 turns/m. A fishing line of round cross section with a diameter of 0.35 mm is obtained, which has an elongation at break of 3.6% and a linear support capability of 31 kg.

#### Exemplary Embodiment 3:

A core is produced from a multifilament yarn of 440 dtex of the same material as described in connection with the exemplary embodiment 1, wherein the multifilament yarns, including their filaments, extend parallel in respect to each other. As can be seen in Fig. 1, the core is sheathed in two small film strips made of PTFE as described in exemplary embodiment 2, so that a closed sheathing is obtained. The fishing line thus obtained has a round diameter of a cross section of 0.28 mm, it has an elongation at break of 3.6% and

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has a linear support capability of 15.5 kg.